## **GENERAL DESCRIPTION**

The SGM4040 is a micro-power, precision shunt voltage reference which is easy to use in many applications. It has a fixed output voltage of 2.5V, and draws operating current up to 15mA. The device has no need for external capacitors and can keep stable with any capacitive load.

The SGM4040 features low temperature coefficient, low output noise, and low dynamic impedance. These characteristics enable the device to output stable voltage over a wide operating temperature and current range.

The SGM4040 offers high accuracy of 0.3% (MAX) for B grade and 0.5% (MAX) for C grade.

The SGM4040 is available in Green SOT-23 and SC70-5 packages. It operates over an ambient temperature range of -40°C to +125°C.

### **FEATURES**

- Fixed Output Voltage: 2.5V
- Wide Operating Current Range: 48µA to 15mA (TYP)
- Output Voltage Accuracy:
  - SGM4040B: 0.3% (MAX)
  - SGM4040C: 0.5% (MAX)
- Low Temperature Coefficient: 20ppm/°C (TYP)
- Low Output Noise: 20µV<sub>RMS</sub> (TYP)
- Stable without External Capacitors
- Stable with Any Capacitive Load
- -40°C to +125°C Operating Temperature Range
- Available in Green SOT-23 and SC70-5 Packages

### **APPLICATIONS**

Precision Data-Acquisition Systems Instrumentation and Test Equipment Industrial Process Controls Precision Audio Components Power Management Battery-Powered Equipment

### **TYPICAL APPLICATION**

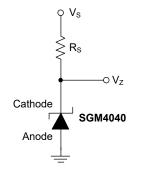
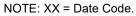


Figure 1. Shunt Regulator Simplified Schematic

# **PACKAGE/ORDERING INFORMATION**

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM4040B-2.5	SOT-23	-40°C to +125°C	SGM4040B-2.5XN3LG/TR	OU8XX	Tape and Reel, 3000
SOM40400 0 5	SOT-23	-40°C to +125°C	SGM4040C-2.5XN3LG/TR	MF4XX	Tape and Reel, 3000
SGM4040C-2.5	SC70-5	-40°C to +125°C	SGM4040C-2.5XC5G/TR	00SXX	Tape and Reel, 3000

#### MARKING INFORMATION





Date Code - Week
Date Code - Year
Serial Number

Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

### ABSOLUTE MAXIMUM RATINGS

Junction Temperature	+150°C
Storage Temperature Range	65°C to +150°C
Lead Temperature (Soldering, 10s)	+260°C
ESD Susceptibility	
HBM	5000V
CDM	1000V

#### **RECOMMENDED OPERATING CONDITIONS**

Reverse Current	. 48µA to 15mA (TYP)
Operating Temperature Range	40°C to +125°C

### **OVERSTRESS CAUTION**

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

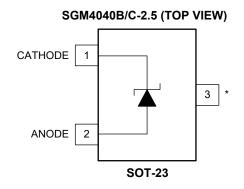
#### **ESD SENSITIVITY CAUTION**

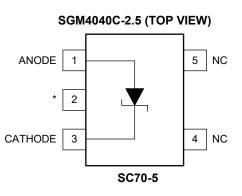
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

#### DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

# **PIN CONFIGURATIONS**





# **PIN DESCRIPTION**

P	PIN		I/O	FUNCTION		
SOT-23	SC70-5	NAME	1/0	FUNCTION		
1	3	CATHODE	I/O	Cathode Pin. Shunt current and output voltage.		
2	1	ANODE	0	Anode Pin. Connect to GND directly.		
3	2	*	_	Must be connected to ANODE pin or left floating.		
_	4, 5	NC	_	Not Connected.		

# SGM4040B-2.5 ELECTRICAL CHARACTERISTICS

(Full = -40°C to +125°C, typical values are at  $T_A$  = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS	
Reverse Breakdown Voltage	Vz	I <sub>Z</sub> = 100μA	+25°C		2.5		V	
Reverse Breakdown Voltage		1 - 100.04	+25°C	-7.5		7.5	mV	
Tolerance		$I_z = 100 \mu A$	Full	-20.5		20.5	mv	
Minimum Cathode Current			+25°C		48	75		
Minimum Cathode Current	I <sub>Z(MIN)</sub>		Full			95	μA	
Average Temperature Coefficient of Reverse Breakdown Voltage		I <sub>z</sub> = 10mA	Full		20			
	αVz	I <sub>Z</sub> = 1mA	Full		20		ppm/°C	
		I <sub>Z</sub> = 100μA	Full		20		]	
			+25°C		1.4	4	mV	
Reverse Breakdown Voltage Change		$I_{Z(MIN)} < I_Z < 1mA$	Full			7.5		
with Cathode Current Change	$\Delta V_Z / \Delta I_Z$		+25°C		2.6	4.5		
with Cathode Current Change		1mA < I <sub>z</sub> < 15mA	Full			6.5		
Reverse Dynamia Impedance	7	1 - 1mA = 0.51	+25°C		0.6	1.5	0	
Reverse Dynamic Impedance	Zz	$I_z = 1mA, I_{AC} = 0.5I_z$	Full			2.5	Ω	
Wideband Noise	en	I <sub>z</sub> = 100µA, 10Hz ≤ f ≤ 10kHz	+25°C		20		$\mu V_{RMS}$	
Thermal Hysteresis (1)	V <sub>HYST</sub>	$\Delta T_A = -40^{\circ}C$ to +125°C			0.05		%	

# SGM4040C-2.5 ELECTRICAL CHARACTERISTICS

(Full = -40°C to +125°C, typical values are at  $T_A$  = +25°C, unless otherwise noted.)

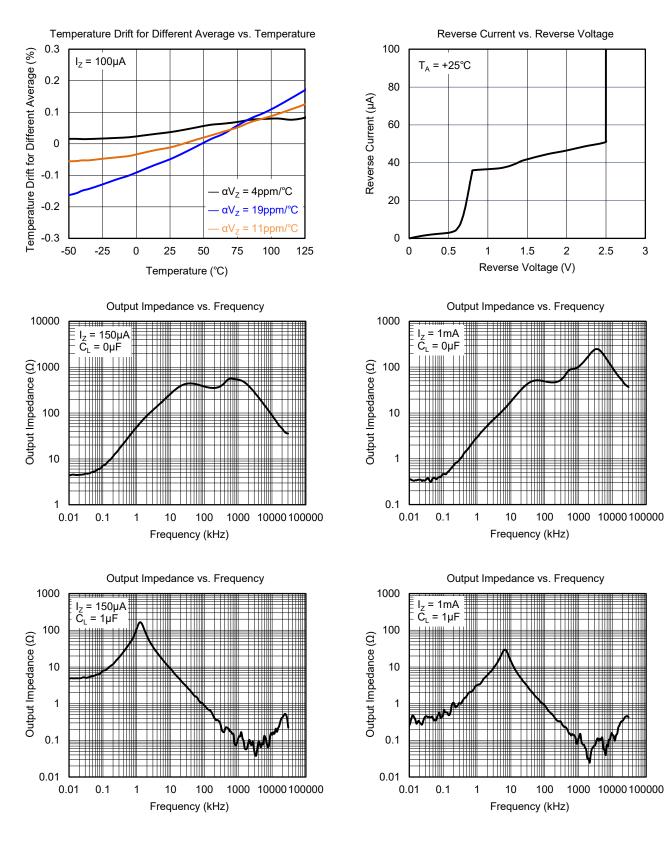
PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS	
Reverse Breakdown Voltage	Vz	I <sub>z</sub> = 100μA	+25°C		2.5		V	
Reverse Breakdown Voltage		$I_{z} = 100 \mu A$ $I_{z} = 100 \mu A$ $I_{z} = 100 \mu A$ $I_{z} = 10 m A$ $I_{z} = 10 m A$ $I_{z} = 100 \mu A$ $I_{z} = 100 \mu A$ $I_{z(MIN)} < I_{z} < 1 m A$	+25°C	-12.5		12.5	mV	
Tolerance		$I_z = 100 \mu A$	Full	-25		25	mv	
Minimum Cathode Current			+25°C		48	75		
Minimum Cathode Current	I <sub>Z(MIN)</sub>		Full			95	μA	
		I <sub>z</sub> = 10mA	Full		20			
Average Temperature Coefficient of Reverse Breakdown Voltage	$\alpha V_Z$	I <sub>Z</sub> = 1mA	Full		20		ppm/°C	
		I <sub>z</sub> = 100μA	Full		20		]	
	$\Delta V_Z / \Delta I_Z$	$I_{Z(MIN)} < I_Z < 1mA$	+25°C		1.4	4	- mV	
Reverse Breakdown Voltage Change			Full			7.5		
with Cathode Current Change			+25°C		2.6	4.5		
with Cathode Current Change			Full			6.5		
Devenes Dumentis lutra dense	7		+25°C		0.6	1.5		
Reverse Dynamic Impedance	Zz	$I_Z = I M A$ , $I_{AC} = 0.5 I_Z$	Full			2.5	Ω	
Wideband Noise	en	I <sub>z</sub> = 100µA, 10Hz ≤ f ≤ 10kHz	+25°C		20		$\mu V_{RMS}$	
Thermal Hysteresis (1)	V <sub>HYST</sub>	$\Delta T_A = -40^{\circ}C$ to +125°C			0.05		%	

NOTE: 1. Thermal hysteresis is defined as the output voltage difference at the +25°C after a temperature excursion to -40°C, then to +125°C, and back to +25°C.

### SGM4040

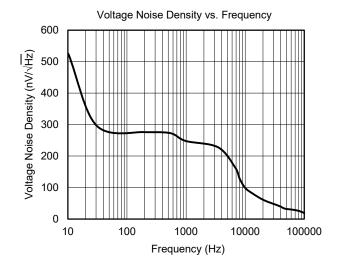
### Micro-Power Precision Shunt Voltage Reference

## **TYPICAL PERFORMANCE CHARACTERISTICS**



# SGM4040

# **TYPICAL PERFORMANCE CHARACTERISTICS (continued)**



# **DETAILED DESCRIPTION**

SGM4040 is a micro-power, high precision, small-footprint, fixed-voltage shunt voltage reference.

#### **Feature Description**

For SGM4040, the precision level of this Zener diode is significant. For the regulation of SGM4040, the required quiescent current for this device is low. Also, shunting the load current to the ground is one method to regulate and it depends on the load resistance and level of input voltage. For operating SGM4040, an external resistor between the cathode and power supply is required for setting the input current. For getting lower noise, an external capacitor is also recommended to filter the noise at the input and output pins of the precision Zener diode.

#### **Device Functional Modes**

The output of SGM4040 is fixed and non-adjustable, which means there is a feedback loop inside the device and the Zener diode operates in the closed-loop mode. Also, the device will work typically if  $I_Z$  is between the range of  $I_{ZMIN}$  and  $I_{ZMAX}$ , so a proper selection of external resistor is important to make sure that the load and cathode current are within the typical range.

## **APPLICATION INFORMATION**

The SGM4040 is designed to provide a voltage reference accurately with ultra-low power dissipation. For the application of critical-space system, the sub-miniature packages (SOT-23 and SC70-5) can be selected. Because of the excellent stability of the shunt voltage reference, the capacitors are not required to be connected between CATHODE and ANODE pins. However, if a bypass capacitor is required, the stability of SGM4040 will not be reduced. For SGM4040, the typical cathode current is 48uA to 15mA, and the reversed breakdown voltage is 2.5V.

Between ANODE pin and CATHODE pin is a parasitic Schottky diode. Therefore, leaving \* pin (pin 3 of SOT-23 package or pin 2 of SC70-5 package) floating or connected to ANODE pin is a good choice.

#### Load Current and Cathode

For the shunt regulator shown in Figure 2,  $R_S$  is required to be connected between  $V_S$  and the cathode of SGM4040. The value of  $\mathsf{R}_{\mathsf{S}}$  is significant for this shunt regulator because it determines how much current can be flowed to the voltage reference itself  $(I_7)$ and the load  $(I_L)$ , and the user needs to make sure that the cathode current  $(I_z)$  is operated within the design specification. However, for one extreme case, if the supply voltage and load is varied (the load current  $I_{l}$  is maximum and the V<sub>S</sub> is minimum), it is recommended that the resistance of R<sub>S</sub> should be selected low enough to guarantee normal operation of the shunt regulator. For the other extreme,  $I_L$  is minimum and  $V_S$ is maximum, the resistance of Rs should be large enough to guarantee that the operating current  $I_Z$  is less than 15mA.

The equation 1 shows the calculation of  $R_s$ .

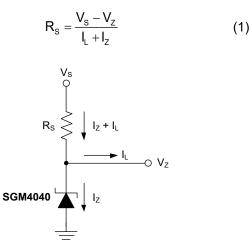


Figure 2. Shunt Regulator

#### Thermal Hysteresis

The definition of thermal hysteresis is the voltage change at +25°C after thermal cycling to -40°C and +125°C respectively. To explain, first finish thermal cycling at -40°C, then measure the output voltage after moving the device into the condition of +25°C. Second, finish thermal cycling at +125°C and then measure the output voltage at +25°C. The difference of the output voltage at these two testing conditions is the thermal hysteresis. The thermal hysteresis is common for the precision device because of the stress of thermal-mechanical package. Also, thermal hysteresis will be contributed by temperature of mounting, operating and storing.

Page

### **REVISION HISTORY**

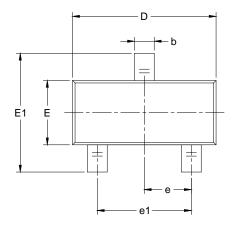
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

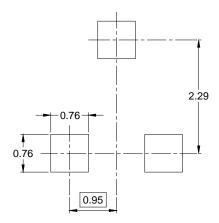
#### Changes from Original (MARCH 2022) to REV.A

Changed from product preview to production dataAll
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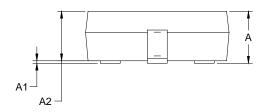
# PACKAGE OUTLINE DIMENSIONS

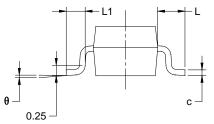
# **SOT-23**





RECOMMENDED LAND PATTERN (Unit: mm)





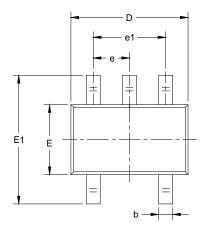
Symbol		nsions meters	Dimensions In Inches		
	MIN	MAX	MIN	MAX	
A	0.89	1.12	0.035	0.044	
A1	0.01	0.10	0.000	0.004	
A2	0.88	0.88 1.02		0.040	
b	0.30 0.50		0.012	0.020	
С	0.08	0.20	0.003	0.008	
D	2.80	3.04	0.110	0.120	
E	1.20	1.40	0.047	0.055	
E1	2.10	2.64	0.083	0.104	
е	0.95 BSC		0.037 BSC		
e1	1.90 BSC		0.075 BSC		
L	0.54 REF		0.021	1 REF	
L1	0.40	0.60	0.016	0.024	
θ	0°	8°	0°	8°	

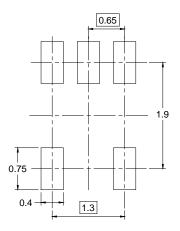
NOTES: 1. Body dimensions do not include mode flash or protrusion.

2. This drawing is subject to change without notice.

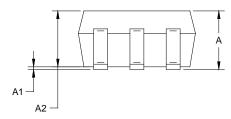
# PACKAGE OUTLINE DIMENSIONS

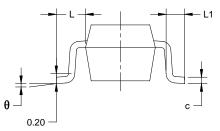
# SC70-5





RECOMMENDED LAND PATTERN (Unit: mm)





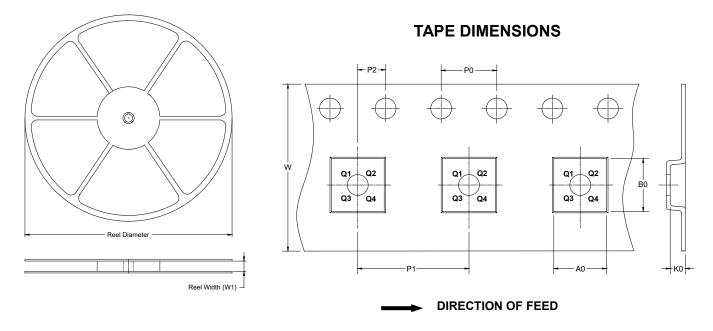
Symbol		nsions meters		nsions ches
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.000	0.100	0.000	0.004
A2	0.800	1.000	0.031	0.039
b	0.150	0.350	0.006	0.014
С	0.080	0.220	0.003	0.009
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
е	0.65	0.65 TYP		6 TYP
e1	1.300 BSC		0.051	BSC
L	0.525 REF		0.021	REF
L1	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°

NOTES:

Body dimensions do not include mode flash or protrusion.
 This drawing is subject to change without notice.

# TAPE AND REEL INFORMATION

#### **REEL DIMENSIONS**

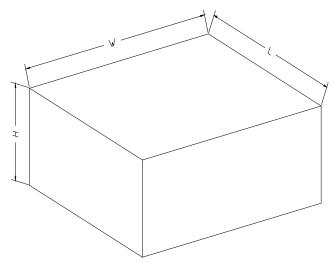


NOTE: The picture is only for reference. Please make the object as the standard.

#### **KEY PARAMETER LIST OF TAPE AND REEL**

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT-23	7″	9.5	3.15	2.77	1.22	4.0	4.0	2.0	8.0	Q3
SC70-5	7"	9.5	2.25	2.55	1.20	4.0	4.0	2.0	8.0	Q3

### **CARTON BOX DIMENSIONS**



NOTE: The picture is only for reference. Please make the object as the standard.

#### **KEY PARAMETER LIST OF CARTON BOX**

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton	
7" (Option)	368	227	224	8	
7"	442	410	224	18	00002